International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)
ISSN (P): 2249-6890; ISSN (E): 2249-8001
Vol. 8, Issue 1, Feb 2018, 399-406

EFFECT OF DIMETHOXY-METHANE ($C_3H_8O_2$) ADDITIVE ON EMISSION CHARACTERISTICS OF A DIESEL ENGINE FUELED WITH BIODIESEL

K. BHASKAR[1], L. R. SASSYKOVA[2], M. PRABHAHAR[3] & S. SENDILVELAN[4]

[1]Department Automobile Engineering, Rajalakshmi Engineering College, Chennai, Tamil Nadu, India

[2]Faculty of Chemistry and Chemical Technology, Al-Farabi Kazakh National University Almaty, Kazakhstan

[3]Department of Mechanical Engineering, Aarupadaiveedu Institute of Technology, Chennai, Tamil Nadu, India

[4]Department of Mechanical Engineering, Dr. M. G. R Educational and Research Institute, University, Chennai, Tamil Nadu, India

ABSTRACT

This paper investigates the utilization of Palm Oil Methyl Ester (PAM) blends with diesel in a compression ignition engine. The performance and combustion characteristics of 20% Palm Oil Methyl Ester and 80% Diesel and also with 10% Dimethoxymethane (DMM) have been studied and it was found that the blends could substitute for diesel and used as an alternate source for the future generation. The addition of additive Dimethoxymethane helps to decrease the carbon monoxide emission and opacity. The adverse effect oxide nitrogen increase due to the biodiesel blends is marginally reduced. It gives better brake thermal efficiency than biodiesel blends.

***KEYWORDS:** Palm Oil Methyl Ester, Dimethoxymethane, Diesel Engine & Emission Reduction*

Received: Dec 06, 2017**; Accepted:** Dec 27, 2017**; Published:** Jan 08, 2018**; Paper Id.:** IJMPERDFEB201844

Original Article

INTRODUCTION

There are some issues due to technology advancement relating to an alternate fuel to sustain the automobile sector for the future. However, our dependence is on diesel and petroleum for fueling the transportation sector and if this continues then this could threaten our energy resource, affect our economy and even affect our environment so badly that it may even take hundreds of years for a seed to sprout [1] [2]. Thus, we are in search of an alternate source of fuel to have a sustainable economy. This is possible with the use of Biodiesel, which is a renewable source of energy. Though it is not possible to run a CI Engine on 100% biodiesel like jatropha and pongamia without any major modifications in the presently available engine, when blended with diesel in various proportions, it would make the world wonder with its Eco-friendly nature [3] [4]. Biodiesel is nothing but long-chain alkyl esters which is obtained from animal fat and plant seeds. They are regarded as a carbon sink as they absorb 78.5% of carbon in the atmosphere as they burn and even considered as cleaner than fossil fuels [5] [6].

Waste oil biodiesel showed an increase in fuel density and decrease in calorific value of fuel [7] [8] and also improved power, thermal efficiency, and reduction in the specific fuel consumption. Waste cooking oil could be produced through the transesterification process [9] [10]. The heating the frying oil to reduce the viscosity to that of diesel and it could be used as an alternative fuel in diesel engine [11] [12]. The biodiesel and its blend fuels show that biodiesel/blend fuels have high break specific fuel consumption at low engine speed [13] [14].

Preheated Palm Oil Methyl Esters (PAM) in the diesel engine it is seen that the improved the brake power

output and engine performance [15] [16]. The specific fuel consumption values of the methyl esters were less than that of the raw vegetable oil and high specific fuel consumption in vegetable oil is due to the lower energy content [17] [18]. Biodiesel is a mixture of glycerin free longchain fatty acids obtained from oils and fats [19] [20]. The diesel Dimethoxymethane (DMM) blends experimentally and reported that the effect of fuel constituents on combustion characteristics, fuel efficiency and emissions of a diesel engine. He also reported that with the use of DMM, CO and smoke emissions can be reduced significantly, while HC emissions and particulate matter increase slightly [21]. To improve the performance of a diesel engine by adding an oxygenated fuel additive to control the emission and to improve its performance.

Previous research showed that the reduction of PM and NOx could be achieved by using DMM blends [22]. However, these studies were performed only for diesel and DMM blends, and only a few researche have done experimental work on Palm Oil Methyl Ester and DMM blends. In this work, the performance of Palm Oil Methyl Ester (PAM) and DMM with diesel in a compression ignition engine have been analyzed. The performers and Combustion characteristics of B20PAMDMM (20% Palm Oil Methyl Ester and 70% Diesel 10% DMM) for various loads have been studied

OXYGENATED ADDITIVE

Fuels that have a chemical compound that contains oxygen atoms are called oxygenated additives. Effective burning is possible with the use of oxygenated additives and also the major benefit is it cut down the emission level comes out of the engine exhaust.The oxygenated additive works by allowing the gasoline in vehicles to burn more completely. Oxygenated additive also helps to reduce the utility of non-renewable fossil fuels exhausted. In recent years, Dimethoxymethane (DMM) has been a promising alternative diesel fuel, since it has a high oxygen fraction and a high cetane number. Such positive advantages make DMM a good oxygenated additive to be used in diesel engines.

In this study, Dimethoxymethane ($CH_3OCH_2OCH_3$, DMM) were analyzed and reported. DMM is non-toxic and miscible with diesel fuels. Dimethoxymethane (DMM) is a high oxygen content additive and also has a high cetane number, which makes DMM a well oxygenate additive for diesel/oxygenate fuel blends. This study, analyses engine performances and emissions with various compression ratios of a compression ignition engine fueled with Palm oil methyl ester with DMM blend with diesel.

EXPERIMENTAL

The research engine test setup with the following configuration has been used for this work. Single cylinder, four stroke, Multifuel water cooled VCR engine. Strokes:110mm, Bore:87.5mm, Capacity 661cc, Power 3.5 kW, speed 1500 RPM, CR range 12:1-18:1.

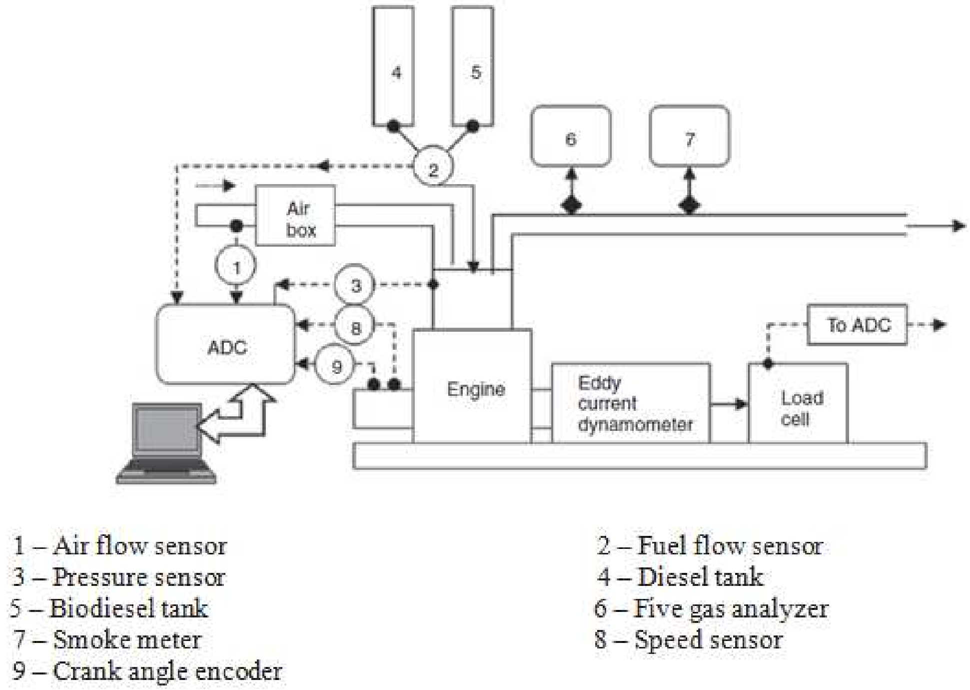

Figure 1: Experimental Setup

Eddy current dynamometer for loading. Experiments were conducted at 17.5 compression ratio with the selected engine loads varied from 0, 3, 6 and 9kg. Before each measurement, the was warmed up and engine running steadily. The brake thermal efficiency, NO_x, HC, CO emissions as well as the opacity is recorded and analyzed in this study. Figure 1 shows the schematic experimental system and measuring instruments used in this work.

RESULTS AND DISCUSSIONS

Figure 2 shows that the variation of brake thermal efficiency with a load for diesel, 20% PAM and 20% PAM with 10% DMM. The result revealed that with increasing a load the brake thermal efficiency increases. 20% PAM shows lowest brake thermal efficiency compared to the other modes. By adding Dimethoxymethane with palm oil increases the brake thermal efficiency, but still, it is lower than diesel. This may be due to the PAM addition which has a lower calorific value than the diesel.

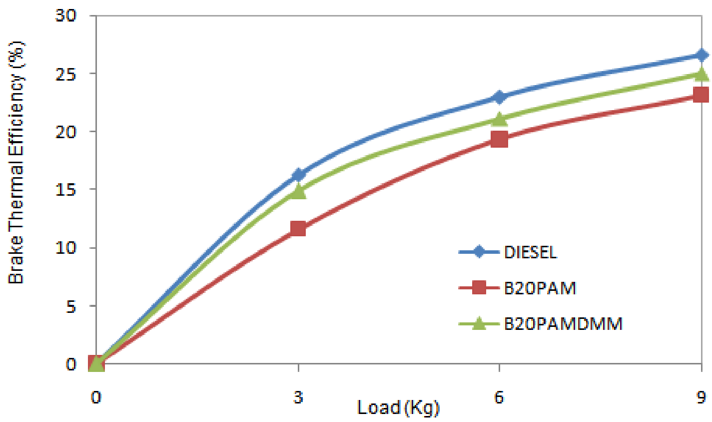

Figure 2: Brake Thermal Efficiency in % with Load in Kg

Figure 3 shows the exhaust CO concentration in % with load in Kg for 20%PAM, 20% PAM with 10% DMM fuel blends. A remarkable decrease in CO is present at high engine loads. Moreover, the PAM and DMM blends show a greater reduction in CO concentration at higher loads. For diesel, the CO concentration is 26.6 % at full load. For 20% PAM, 20% PAM with 10% DMM the variations are 23.1 and 25 % respectively.

Figure 4 gives HC emissions in ppm versus load in kg. The HC concentration is lower in the case of 20PAM blends obviously PAM oxygenated fuel supports better combustion with diesel. The expected reduction of HC is not happened with the addition of 10% DMM considered as higher oxygen mass (8.46). This may be due to the boiling point of DMM, which is 40°C below the diesel. DMM disperses all areas before the flame reaches, which could be the reason for higher HC. For diesel, the HC emissions vary from 18 ppm at no load to 25 ppm at rated power output. For 20% PAM, 20% PAM with 10% DMM the variations are from 17 ppm to 22 ppm, 18 ppm to 25 ppm respectively.

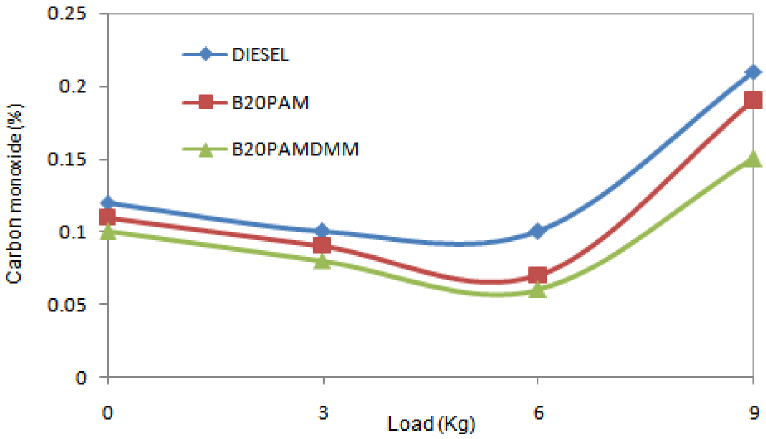

Figure 3: Carbon Monoxide in % with Load in Kg

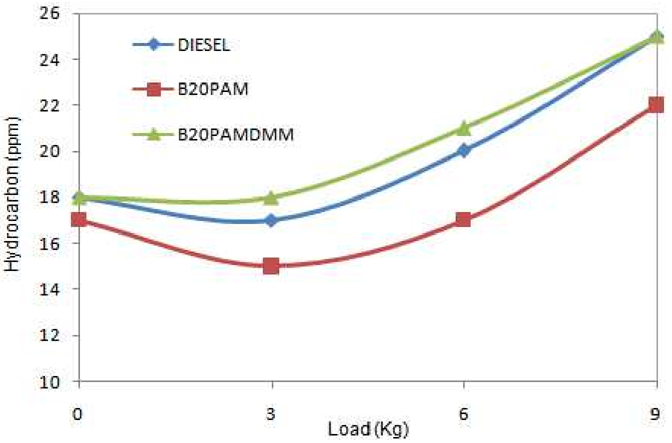

Figure 4: Hydrocarbon in ppm with Load in Kg

The NO_x concentration of diesel, 20 PAM and 20 PAM with 10% DMM blends under various loads shown in Figure 5. The NO_x concentration is high at full load condition, particularly with 20 PAM blends with diesel shows more concentration of NO_x. The addition of DMM in the blend shows a reasonable decrease in NO_x at all loads, but slightly higher than diesel fuel. For diesel, the NOx emissions vary from 59 ppm at no load to 894 ppm at rated power output. For 20% PAM, 20% PAM with 10% DMM the variations are from 122 ppm to 1356 ppm, 122 ppm to 1077ppm respectively.

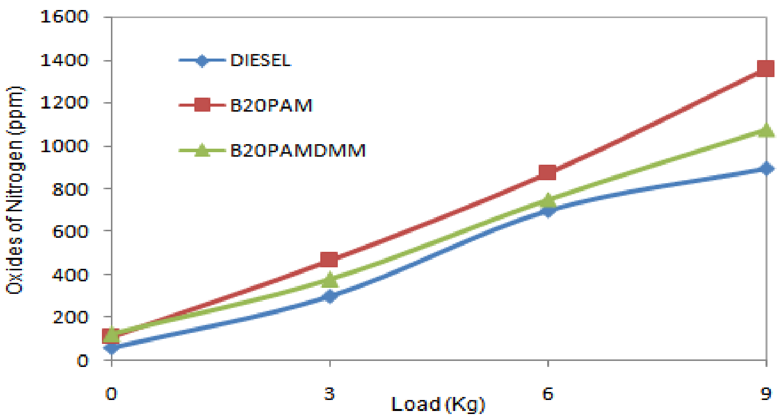

Figure 5: Oxides of Nitrogen in Ppm with Load in Kg

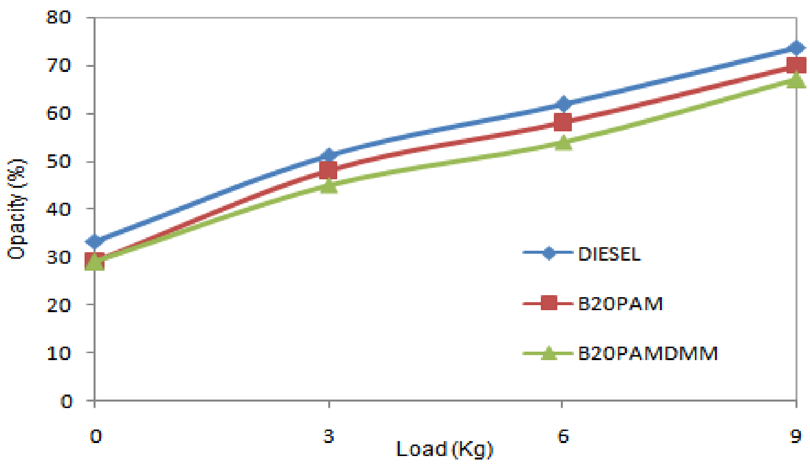

Figure 6: Opacity in % with Load in Kg

Figure 6 gives the exhaust opacity versus engine load for the diesel, diesel with 20 PAM and diesel with 20% PAM also 10% DMM blends. The opacity increases with increase in load for all modes. DMM has low viscosity and lower boiling point compared with diesel and PAM, which gives better mixing, reduces the formation of soot and a total number of particles. The DMM promotes oxidation of soot and the conversion CO to CO_2 increases. The formation of large particulates will be slowed down by the DMM.

CONCLUSIONS

The performance and emissions of a compression ignition engine fueled with diesel and PAM blends and biodiesel/DMM blends were investigated, and the results are summarized below.

- The engine thermal efficiency decreases by 20% PAM blends with diesel. But there are increasesin the BTE with biodiesel/DMM blends compared with 20% PAM blends.
- The carbon monoxide concentration is low with biodiesel/DMM blends compared with other blends.
- Oxides of Nitrogen increases slightly for both the 20% PAM blends and biodiesel/DMM blends compared to the diesel.
- Opacity concentration considerable reduced with biodiesel/DMM blends.

Energy crisis caused due to disproportionate dependence on non-renewable energy resources fossil fuels. If the fossil fuel production remains constant, it is estimated that the reserves will be deleted soon. Due to the running down of the world’s petroleum reserves and the growing environmental concerns, there is an extensive demand for non-conventional sources of energy. Augmented regulations for particulate matter and NOx, and the issues raised on the emission of greenhouse gases like CO_2 are the reasons for bio-fuels being subjected to demanding research work all over the world. Biodiesel derived from the transesterification of fats and oils is a possible fuel for diesel engines.

REFERENCES

1. *Atabani, A. E., Badruddin, I. A., Mekhilef, S., &Silitonga, A. S. (2011). A review on global fuel economy standards, labels and technologies in the transportation sector. Renewable and Sustainable Energy Reviews, 15, 4586–4610.*
2. *Salvi, B. L., Subramanian, K. A., &Panwar, N. L. (2013). Alternative fuels for transportation vehicles: A technical review. Renewable and Sustainable Energy Reviews, 25, 404–419.*
3. *No, S. Y. (2011). Inedible vegetable oils and their derivatives for alternative diesel fuels in CI engines: A review. Renewable and Sustainable Energy Reviews, 15, 131–149.*
4. *Nantha Gopal, K., &Thundil Karupparaj, R. (2014). Effect of pongamia biodiesel on emission and combustion characteristics of di compression ignition engine. Ain Shams Engineering Journal, 6, 297–305.*
5. *Ali, H., Mashud, M., &Rubel, R., et al. (2013). Biodiesel from Neem oil as an alternative fuel for diesel engine. Procedia Engineering, 56, 625–630.*
6. *Knothe, G., &Steidley, K. R. (2011). Kinematic viscosity of fatty acid methyl esters: Prediction, calculated viscosity contribution of esters with unavailable data, and carbon-oxygen equivalents. Fuel, 90, 3217–3224.*
7. *Yamin, J. A., Sakhnini, N., Sakhrieh, A., &Hamdan, M. A. (2013). Environmental and performance study of a 4-Stroke CI engine powered with waste oil biodiesel. Sustainable Cities and Society, 9, 32–38.*
8. *Sendilvelan, S., &Bhaskar, K. (2017). Aluminium phosphate supported copper phosphate catalytic converter to reduce nitrous oxides and particulate matter from engine emission. Oriental Journal of Chemistry, 33, 2111-2117*
9. *Farooq, M., Ramli, A., &Subbarao, D. (2013). Biodiesel production from waste cooking oil using bifunctional heterogeneous solid catalysts. Journal of Cleaner Production, 59, 131–140.*
10. *Sendilvelan, S., &Bhaskar, K. (2017). Comparative performance studies on DI diesel engine with neem de-oiled cake and Jatropha methyl ester diesel blends. World Journal of Engineering, 14, 348-352.*
11. *Pugazhvadivu, M., &Jeyachandran, K. (2005). Investigations on the performance and exhaust emissions of a diesel engine using preheated waste frying oil as fuel. Renewable Energy, 30, 2189–2202.*
12. *Sundar Raj, C., Arul, S., Sendilvelan, S., &Saravana, n C. G. (2010). A comparative assessment on performance and emissions characteristics of a diesel engine fumigating with methanol, methyl ethyl ketone, and liquefied petroleum gas. Energy Sources, Part A: Recovery, Utilization and Environmental Effects, 32, 1603-1613.*
13. *An, H., Yang, W. M., Chou, S. K., &Chua, K. J. (2012). Combustion and emissions characteristics of diesel engine fueled by biodiesel at partial load conditions. Applied Energy, 99, 363–371.*
14. *Kathirvelu, B., Subramanian, S., Govindan, N., &Santhanam, S. (2017). Emission characteristics of biodiesel obtained from jatropha seeds and fish wastes in a diesel engine. Sustainable Environment Research, 27, 283–290.*

15. *Nagaraja, S., Sooryaprakash, K., &Sudhakaran, R. (2015). Investigate the Effect of Compression Ratio Over the Performance and Emission Characteristics of Variable Compression Ratio Engine Fueled with Preheated Palm Oil - Diesel Blends. Procedia Earth and Planetary Science, 11, 393–401.*

16. *Murali Manohar, R., Prabhahar, M., &Sendilvelan, S. (2012). Experimental investigation of combustion and emission characteristics of engine is fueled with diesel and UVOME blends of B20K and B80K. European Journal of Scientific Research, 76, 327–334.*

17. *Demirbas, A. (2008). Relationships derived from physical properties of vegetable oil and biodiesel fuels. Fuel, 87, 1743–1748.*

18. *Sendil Velan, S., Jeyachandran, K., &Bhaskar, K. (2001). Experimental investigation of emission control from spark-ignition engine using electrically heated catalyst. SAE Technical Papers, 2001-01-2000.*

19. *Avinash Kumar Agarwal. (2007). Biofuels (alcohols and biodiesel) applications as fuels for internal combustion engines, Progress in Energy and Combustion Science, 33(3), 233-271.*

20. *Sendilvelan, S., &Bhaskar, K. (2017). Chemical and experimental analysis of fumigation process to reduce emission without affecting the performance of an engine. Rasayan Journal of Chemistry, 10, 111-116.*

21. *Sendilvelan, S., &Rajan, K. (2017). Effect of butanol-diesel blends in a compression ignition engine to reduce emission. Rasayan Journal of Chemistry, 10, 190-194.*

22. *Daming Huang, Haining Zhou& Lin Lin, (2012). Biodiesel: an Alternative to Conventional Fuel, Energy Procedia, 16, 1874-1885.*